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Paula H. Doughty
Director, Environmental Affairs

M/035/002

Kennecott

RECEIVED
AUG 2 4 2004
DIV. OF OIL, GAS & MINING

August 16, 2004

CERTIFIED MAIL
Mr. Daron Haddock, Permit Supervisor
Minerals Reclamation Program
Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 841114-5801

Dear Mr. Haddock:

Subject: <u>Results of Kennecott Utah Copper Corporation Slope Stabilization Study for Permit Number M/035/002</u>

Attached with this letter is a report containing the results of a slope stabilization study performed on all the Kennecott Utah Copper Corporation (KUCC) waste disposal areas and a reclamation design and cost estimate for the South End waste disposal areas. Agreement on the scope of this study was reached by members of your staff through approval of the Bingham Canyon Mine 2003 Reclamation and Water Management Plan (Permit Number M/03/002) via correspondence received on June 11, 2003. As part of that plan, KUCC agreement to perform a slope stabilization study by March 2005.

SLOPE STABILIZATION STUDY

Although the original slope stabilization study was to be performed on only the southeast margin of the waste rock disposal areas, known as the Butterfield and/or South End waste rock piles, the stability study encompassed all of the Kennecott Utah Copper Corporation (KUCC) waste rock.

The primary risks considered in this study included shallow surface slumps and debris flows, deep seated large-scale failure, and acid rock drainage (ARD). Dr. Call from Call and Nicholas Inc. out of Tucson, Arizona, was contracted to complete the study. Dr. Call stressed the operational slope stability risk associated with high finger dumps constructed at a rapid rate of advance, the risk of small and large scale contaminated water and sediment release from shallow slumps and debris flows following rain events, along with recommendations on overall geotechnical and geochemical (ARD) implications related to slope reduction and stabilization.

No critical risks were identified, however two "likely" risks with "moderate" consequences were noted including:

- Operational risks associated with shallow slumps and debris flows from high finger dumps constructed at a rapid rate of advance for the dumps in Bingham Canyon
- Shallow slumps and debris flow from South End dumps following severe rain events flowing off KUCC property

Dr. Call's report also mentioned, that although the probability of ARD breaching the cut off wall system and flowing into the Salt Lake Valley aquifer is "unlikely", the consequence would be "very high". Thus, Dr. Call stresses maintenance of the cut off wall collection system.

There was only one risk identified with a "high" consequence:

- Major haulage of dump material and increased ARD and erosion by regrading the East Dumps due to a new environmental requirement.

This activity would have a high consequence and negative environmental impact since the disturbed East dump material would extend beyond the cut off wall system and would result in increased production of ARD. The risk level was addressed as a critical comment and a likelihood rating was not assigned since the hazard is political rather than geotechnical.

Some unlikely risks were also identified with a "low" to "moderate" consequence. All findings and recommendations are thoroughly summarized in Dr. Call's report (Attachment A).

REGRADING DESIGN AND ENGINEERING COST ASSESSMENT

An engineering assessment of the cost and efficacy of various slope stabilization methods for the South End waste rock piles has also been completed. Bill Rose of WLR Consulting Inc. based in Lakewood Colorado was contracted to perform the design work. A cost estimate has also been completed based on the reclamation design. All work was performed using Minesight® software and the topographic maps showing the potential contoured surfaces were created in AutoCAD R-2000 from the Minesight® files.

The existing angle of repose slopes for the South End waste rock piles are approximately 1.5:1. The slopes can be reduced by cutting material from the top of the slope and using it as fill material at the bottom of the slope. Cut and fill iterations were performed with final slopes of 2.5:1 and 2.75:1. The preservation of cut off walls was

3.0 OBSERVATIONS ON RISKS CONSIDERED

3.1 Shallow Surface Slumps and Debris Flows

The primary causes of slumps and debris flows are sudden heavy precipitation or snowmelt and/or water on the dump surface flowing over the dump crest. Contributing factors are fines concentrated on the dump outslope and degradation of run-of-mine waste rock. In active dumps, slumps can be the result of oversteepening because of too rapid a dumping rate.

The consequences of this type of event can be a debris flow that extends beyond water cutoff and containment structures, resulting in downstream contamination. The attached map shows the location of source controls including cutoff walls, catch basins, collection pipelines, and monitor wells along the length of the Bingham, East and South dumps.

An example of this type of event is the 1997 debris flow of the South dump into the Olsen drainage. An estimated 1100 tons of sediment passed over the containment structures. Some sediment continued to flow downstream in Butterfield creek and a small amount ultimately entered the Herriman irrigation system. This event was triggered by 1.32 inches of rain in a one-hour period.

3.1.1 South Dumps

The South dumps are the most critical for this type of event as the material in the dump face is finer grained and more altered than most of the other KUC dumps, so that slumping is more likely. Also the potential of contamination extending off company property is greater.

The short term remediation possibilities are additional check dams and control of the water on the surface of the dump to minimize saturation of the material in the dump face. For the long term, the reclamation planning team is considering resloping and revegetation.

3.1.2 East Dumps

The East dumps are likely to have small debris flows that are contained above or in the cutoff structures. The consequence of these flows is relatively minor, consisting chiefly of cleaning out the cutoff structures.

The East dumps are older, inactive dumps composed in large part of quartzite, which is less subject to alteration and tends to remain a coarser material. Also, portions of the dumps have been recontoured with reduced slope angles and some areas are vegetated.

Therefore a debris flow extending past the containment structures is unlikely, but the consequences are greater, because there would be contamination below the containment structures. Even so, there is a low probability that the contamination would exit off company property.

3.1.3 Upper Dumps

The upper dumps are older and have some revegetation, so slumping is unlikely. Debris flows would be into the pit area, so the environmental consequences would be minor. It is considered very unlikely that the debris flows would reach any active mining areas.

3.1.4 Bingham Dumps

The Bingham dumps are currently active so slumping due to normal consolidation is likely. However, debris flows extending past the containment structures is unlikely. The more probable consequence would be disruption of select water quality monitoring wells located near the toe of the active finger dump.

Slumping can be minimized by 1) control of the dumping rate, 2) shape of the dump face, and 3) control of the location of unfavorable (low-strength) material.

The current reclamation plan for the Bingham Canyon dumps is to recontour and stair-step the final dump face to a 2.75:1 slope and to cap and revegetate the dump faces.

3.2 Deep Seated Large-Scale Failure

The probability of a deep seated failure of the inactive older KUC dumps is very low, even if the dumps are assumed to have been at limiting equilibrium when constructed. There are three factors that contribute to their current stability:

1. The dumps have consolidated because of settlement over time, which has increased their effective shear strength.
2. The empirical evidence from excavation and drilling of older dumps is that cementing of the dumps has occurred with a significant increase in effective

shear strength. This cementing is from the deposition of iron oxide compounds from the chemical weathering of sulfide-bearing rock.

3. During leaching of the dumps, there was significant localized pore pressure generated by the addition of leach water. With the leaching now stopped, the pore pressure will have decreased so the dumps have a greater effective shear strength and are more stable than they were during leaching.

The consequence of a large-scale KUC dump failure would be significant, because the material and resulting contamination would extend beyond the cutoff structures. The overall risk level is relatively low, however, because of the low probability of occurrence. Nonetheless, controlling the water on the surface of the dumps to minimize water infiltration, thereby reducing the likelihood of generating localized excess pore pressure, should be considered as a mitigation measure.

The dumps should have a displacement monitoring system and periodic geotechnical inspections. Past monitoring of the dumps has shown that significant measurable displacement occurs prior to any major instability. The monitoring system would provide quantitative data to confirm stability or to anticipate major movement.

3.3 Acid Rock Drainage

The evidence presented during the inspection indicates that the Eastside collection system is effective in containing the acid rock drainage (ARD). The cutoff system was constructed to handle 25,000 gpm from dump leaching. With the termination of leaching, the flows have declined to less than 1,000 gpm, so the system has the capacity to handle flows much greater than a 10-year, 24-hour storm event.

Since the consequences of ARD going into the Salt Lake basin are very high, maintenance of the collection system is very important. Capturing runoff from above the dumps, and surface water on the dumps, would reduce the infiltration of water into the dumps and the resultant generation of ARD.

3.4 Bingham Canyon Active Dump

The final configuration of the Bingham Canyon dump as presented in the reclamation plan is a recontoured slope with a maximum angle of 2.75 to 1 to be capped and vegetated. This plan should have an acceptably low risk of failure.

The current plan of building out a finger dump to avoid covering the lower Dry Fork monitoring wells and drilling through the dump to reestablish these monitoring wells is of greater concern, particularly as there are some tight constraints on the time during which the monitoring wells are not functioning. This plan requires rapid dumping with an unfavorable dump geometry, which increases the likelihood of both slumping and deep seated instability. Efforts should be made to alleviate the need to maintain the select monitoring wells at the immediate dump base. This would allow dumping in a more favorable broad dump configuration at a lower rate of advance.

Controls on the rate of face advance, dump face geometry, and location of unfavorable material placement, based on geotechnical evaluations, are required. Also, real-time displacement monitoring (i.e., extensometers) and regular geotechnical inspection should be instituted.

3.5 Angle of Repose East Side Dumps

The current reclamation plan will leave the high angle of repose East dumps as they are. There is a possibility that a new regulation would require resloping and revegetation of these dumps because of the construed negative visual impact. This regulation would have a high consequence because of the quantity of material that would have to be moved for resloping and because of the difficulty of revegetation due to the pyrite content, salinity, and low pH of dump material. Also, resloping would have a negative environmental impact, because disturbing the cemented and stable material would result in increased production of ARD and loose material, which is more subject to erosion.

The likelihood of this consequence is political rather than geotechnical, so the determination of likelihood should be done by someone more familiar with the regulatory environment. Because of this, the consequence of a regulatory requirement was assessed as a "critical comment" in the context of this inspection.

4.0 RECOMMENDATIONS

4.1 South Dump Debris Flow

The highest risk noted during this review is a repeat of the 1997 South dump debris flow. Having a repeat of a previous event would be an unfavorable indication of failure to deal with known risks. The effectiveness of existing containment structures should be evaluated and additional containment structures constructed as needed.

4.2 Surface Water Control

Controlling surface water on the dumps to minimize infiltration and runoff over the crest has a positive effect on both shallow and deep seated instability, and it reduces ARD. The capture of runoff above the dumps should be reevaluated and the top surface of the dumps should be regraded to control water flow.

4.3 Inactive Dump Monitoring

Survey points should be placed on the inactive dumps so displacement can be monitored to confirm stability and to provide early indications of instability. Monitoring should be completed monthly as a part of a routine geotechnical inspection.

4.4 Active Dump Design and Monitoring

The procedures for trucks as described in the document *Dumping at the Dump* are very good. Operator awareness is an important part of the safety program. Truck spotting should be practiced. However, it is inappropriate to leave the monitoring and geometry of dump faces solely to the truck drivers. A geotechnical dump plan/design must be developed for the active Bingham Canyon dump. Geotechnical evaluation of dumping rate, dump geometry, and placement of material should be ongoing; rapidly building a nose with poor material greatly increases the probability of instability.

The active dumping areas should have real-time displacement monitoring (extensometers) and regular geotechnical inspection. If an accident were to occur due to dump instability, there could be an issue of negligence given the past success of predicting dump instability with monitoring.

RDC 12/16/03
Revised 2/25/04
Revised 4/5/04

stressed in the reclamation design, since they are the source controls and most effective method of containing acid rock drainage (ARD) from the waste rock. Cut off walls were upgraded or installed in the early to mid 1990's as part of the groundwater remediation activities completed in accordance with the Administrative Order on Consent for the Zone A groundwater plume (USEPA Docket No. CERCLA No. 86-C-0902C), and with the Record of Decision, Kennecott South Zone Site (U.S. Environmental Protection Agency, 2001).

For each iteration, the slopes were designed with 15ft wide benches every 150ft to act as water breaks that will help prevent erosion and formation of gullies on the slope face. The results of the iterations are summarized in Table 1.

Table 1. Regrading Design of the South End Waste Rock Areas

Iteration Number	Slope Angle	Cubic Yards Moved	Tons Moved	Newly Disturbed Acres	Cutoff Walls Covered
1	2.5:1	25,000,000	42,000,000	140	2
2	2.75:1	31,000,000	53,000,000	174	5

Although shallow slopes (2.75:1) allow for safer access for reclamation and seeding equipment, they also require that more material be moved for greater distances, native undisturbed land at the foot of the dump slope be covered with waste rock, and that more cutoff walls be covered with waste rock. The cutoff walls and associated sumps and pipelines are the primary water collection systems at the foot of the South End waste rock piles and prevent ARD contamination of the underlying aquifer.

Due to the NRD/CERCLA obligations for maintaining cutoff walls and groundwater protection, the most feasible slope reduction option, with the least impact on the collection system, includes a slope reduction of 2.5:1. In this option, all the cutoff walls are preserved except for two in the Olsen and Castro South Drainages. Using this plan, approximately 25,000,000 cubic yards of material will need to be moved and 140 acres of native land would be disturbed. The area of the regraded surface is estimated at 481 acres. Inter-basin or drainage transfers will comprise approximately 10 to 13% of the total waste rock handled.

A 1" = 600' scale map (Drawing No. 454-T-0031) showing the topographic contours for the 2.5:1 regraded surface is contained in Attachment B. The top and toe of the existing dump angle of repose slopes are shown as yellow lines on the map. The cutoff wall locations are shown as short red dashes in the drainages beneath the waste rock dumps. Table 2 (Attachment B) contains a cost estimate for regrading, topsoil application and vegetating the South End waste rock piles by drainage. The total cost for reclaiming the South End Waste Rock piles is $43,188,340 with 20% contingency.

Cost estimates are based upon $1.30 per cubic yard for movement (cut and fill) of waste rock, $9680 per acre for soil hauling and placement of an 18" cap, and $500 per acre for drill, seed and cross rip. KUCC is carefully evaluating all impacts related to reducing the slope and reclaiming the South End waste rock piles.

Please contact me at 569-7120 or Vicky Peacey at 569-7118 if you have any questions or comments relating to this study.

Sincerely,

Paula Doughty

Paula Doughty
Director, Environmental Affairs

Attachments:
cc: Dan Hall (DWQ)

ATTACHMENT A

RISK ASSESSMENT OF KENNECOTT UTAH COPPER CORPORATION MINE WASTE ROCK DISPOSAL AREAS

by

Call & Nicholas, Inc.

CALL & NICHOLAS, INC.

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Principals
D. E. Nicholas, P.E
P. F. Cicchini, P.E.
T. M. Ryan, P.E.
P. R. Pryor, P.E.

MEMORANDUM

TO: Dr. Zavis Zavodni / Rio Tinto Technical Services

FROM: Richard D. Call, P.E.

DATE: 5 April 2004

SUBJECT: Review of Bingham Waste Dumps

1.0 INTRODUCTION

This report is the result of a risk assessment of the Kennecott Utah Copper (KUC) Bingham mine waste dumps. Three days (19-21 November 2003) were spent visually inspecting the dumps, meeting with Bingham personnel, and reviewing documents provided. Dr. Zavis Zavodni of Rio Tinto Technical Services participated in the review as the internal reviewer. The conclusions of this review are based on information from oral presentations and documents provided. No independent verification of the accuracy and completeness of the information was made.

2.0 RISK ASSESSMENT

The risk assessment presented in Table 1 is based on the likelihood and consequence classifications established by Rio Tinto (Appendix A). The primary risks considered were:

1. Shallow surface slumps and debris flows
2. Deep seated large-scale failures
3. Acid rock drainage

The waste dumps were grouped into the following areas as shown on Figure 1:

1. South dumps
2. East dumps
3. Upper dumps
4. Bingham Canyon dumps

Table 1. Bingham Waste Dump Hazard Evaluation

No.	Hazard Description	Likelihood Rating	Consequences		Risk Level	Existing Controls	Possible Mitigation Measures
			Description	Rating			
1	**South dumps**						
1a	Shallow surface slumps and debris flows	Likely	Mud flow into Butterfield Creek and Herriman	Moderate	5	Water cutoffs and check dams	Additional check dams Control of surface water to minimize flow over crest Resloping and vegetation
1b	Deep seated large-scale failure	Very unlikely	Slide debris into Butterfield Canyon	Moderate	3		Control of surface water to minimize pore pressure in dumps Monitoring displacement to confirm stability
1c	Acid rock drainage passing cutoffs	Unlikely	Contamination of Butterfield Creek and Herriman water supply	Moderate	4	Water cutoffs and check dams	Control of surface water
2	**East dumps**						
2a	Shallow surface slumps and debris flows retained above cutoff	Likely	Debris in cutoff structures	Very low	3	Minor check dams	Additional check dams Control of water on dump to minimize dump saturation and flow over crest
2b	Shallow surface slumps and debris flows extending beyond cutoff structures	Unlikely	Contamination beyond cutoff	Moderate	4	Minor check dams	Additional check dams Control of water on dump to minimize dump saturation and flow over crest
2c	Deep seated large-scale failure	Very unlikely	Contamination beyond cutoff	Moderate	3	Dump leaching discontinued	Control of water on dump to minimize dump saturation and flow over crest Monitoring displacement to confirm stability
2d	Acid rock drainage passing cutoffs	Unlikely	Contamination requiring major remediation	Moderate	4	Cutoffs and monitoring wells	Control of water on dump to minimize infiltration of surface water
2e	New environmental requirement to reslope and revegetate dumps	???	Major haulage of dump material increased ARD and erosion	High	Crit C.		

Table 1. Bingham Waste Dump Hazard Evaluation

No.	Hazard Description	Likelihood Rating	Consequences		Risk Level	Existing Controls	Possible Mitigation Measures
			Description	Rating			
3	**Upper dumps**						
3a	Shallow surface slumps and debris flows	Unlikely	Accumulation of debris at toe of dump and possible transgression into upper pit	Very low	2	Some revegetation	Control of surface water to minimize flow over crest Revegetation
3b	Deep seated large-scale failure	Very unlikely	Slide material in pit	Low	2		Control of surface water to minimize pore pressure in dump
3c	Acid rock drainage	Likley	Contaminated water flowing into upper pit	Very low	3		Control of surface flow and cutofs above dump
4	**Bingham dump**						
4a	Shallow surface slumps and debris flows	Likley	Accumulation of debris at toe of dump Loss of truck and or dozer	Moderate	5	Operational dumping pratice	Control of dumping rate, dump shape and material distribution Geotechnical monitoring and design
4b	Deep seated large-scale failure	Very unlikely	Slide material extending beyond dump toe Loss of truck and or dozer	Moderate	3	Operational dumping pratice	Control of dumping rate, dump shape and material distribution Geotechnical monitoring and design
4c	Acid rock drainage passing cutoff	Unlikley	Contamination beyond cutoff	Moderate	4	Cutoffs and lower Bingham Canyon remediation	Control of dumping rate, dump shape and material distribution Geotechnical monitoring

APPENDIX A. Risk Assessment Classifications[1]

A-1. Likelihood Classification

	Very Unlikely	Unlikely	Likely	Highly Likely
Frequency of multiple events	>1/10 years	1/year to 1/10 years	1/month to 1/year	>1/month
Probability of single events	<0.1%	0.1% - 1%	1% - 10%	>10%

A-2. Consequence Classifications

Economic Consequence Classifications

	Consequences			
	Very Low	**Low**	**Moderate**	**Severe**
Annualised Opex or Capex or Revenue	< 5%	5% - 10%	10% - 15%	> 15%
Project Delay (critical path)	< 1 month	1 - 3 months	3 - 6 months	> 6 months

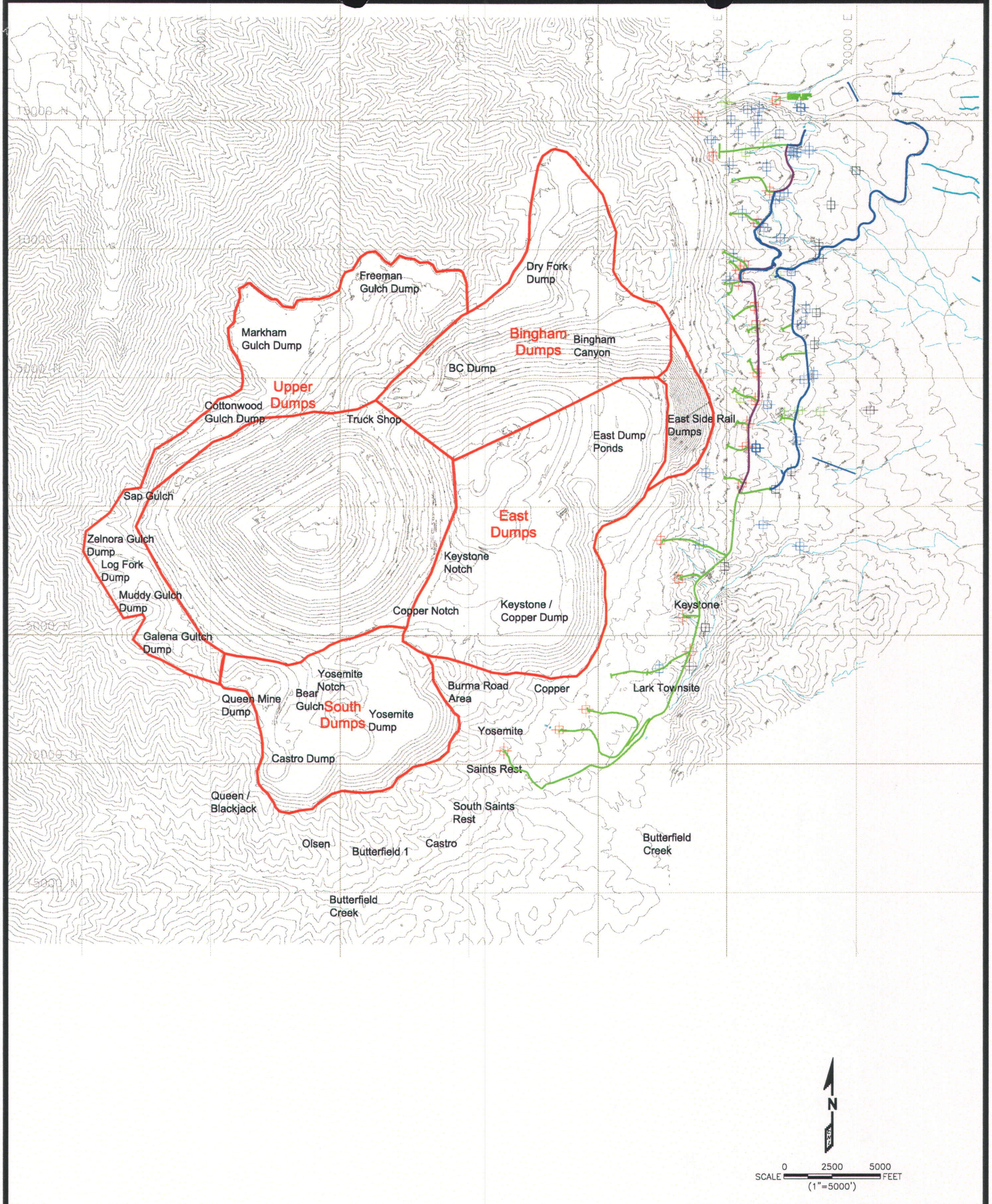
Non-Economic Consequence Classifications

	Consequences			
	Very Low	**Low**	**Moderate**	**High**
Environmental Impact	Localised Degradation	Extended Degradation	Severe Degradation	Catastrophic Degradations
Community Impact	Negligible	Slight	Moderate	Severe
Personnel Safety	No Injuries	Minor Injuries	Serious Injuries	Fatalities
Rio Tinto Reputation	Negligible	Slight	Moderate	Severe

A-3. Risk Determination Matrix

	Most Serious Consequence			
	Very Low	**Low**	**Moderate**	**High**
Very Unlikely	Level 1	Level 2	Level 3	Level 4
Unlikely	Level 2	Level 3	Level 4	Level 5
Likely	Level 3	Level 4	Level 5	Level 6
Highly Likely	Level 4	Level 5	Level 6	Level 7

[1] Vick, Steven G., PE, March 31, 2003, Final tailings facility review, Letter Report to Mr. Felix Blatt, Kennecott Utah Copper, Magna, Utah, USA. Prepared by Steven Vick,PE, Bailey, Colorado, USA



LEGEND	
LEACH WATER COLLECTION SYSTEM	COMPLIANCE MONITORING WELLS
STORM WATER COLLECTION SYSTEM CANAL	OPERATIONAL MONITORING WELLS
STORM WATER COLLECTION SYSTEM UNDERGORUND	LEACH AND METEORIC LEACH WATER COLLECTION SITES
CUTOFF WALLS AND COLLECTION PIPES	TUNNELS, SURFACE SEEPS, AND REPOSITORY LEACHATE COLLECTION SUMPS
	DRAINAGE PATTERNS

CALL & NICHOLAS, INC.

TUCSON, ARIZONA USA

BINGHAM CANYON DUMP LOCATIONS MAP

KENNCOTT / BINGHAM

DRAWN	LMC	DATE	4/04	APPROVED
FILE	BING\2003\DUMPSTUDY\DUMP_LOC.DWG	SCALE	1"=5000'	FIGURE 1

ATTACHMENT B

REGRADING DESIGN OF THE SOUTH END
WASTE ROCK DISPOSAL AREAS

by

WRL Consulting, Inc.

and

RECLAMATION ENGINEERING COST
ESTIMATE OF THE SOUTH END WASTE ROCK
DISPOSAL AREAS

REGRADING			
South End Drainage Basin	**Estimate Volumed (cy x 1000)**	**20% Contingency**	**Regrading Costs**
Yosemite	4,087,000	4,904,400	6,375,720
Saints Rest	7,254,000	8,704,800	11,316,240
South Saints Rest	3,081,000	3,697,200	4,806,360
North Castro	1,514,000	1,816,800	2,361,840
South Castro	2,788,000	3,345,600	4,349,280
Butterfield	1,894,000	2,272,800	2,954,640
Olsen	3,280,000	3,936,000	5,116,800
Queen	648,000	777,600	1,010,880
Total Cost	$24,546,000	$29,455,200	$38,291,760
Regrading unit cost: $1.30			

TOP SOIL	
Total Slope Area	481 acres
Topsoil Depth	1.5 ft
Haul	$2.25/cy
Placement	$1.75/cy
Subtotal Unit Cost	$4.00/cy
Total Cost	$4,656,080

REVEGETATION	
Total Slope Area	481 acres
Drill, Seed, Crossrip	$500/acre
Total Cost	240,500

GRAND TOTAL	
Regrading Subtotal	$38,291,760
Topsoil Subtotal	$4,656,080
Revegetation Subtotal	$240,500
TOTAL DUMP RECLAMATION	$43,188,340

Reference: Bill Rose Estimate July 2002

TABLE 2. South End Waste Rock Piles Recontouring and Revegetation